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Residence- and Source-based Taxation of Capital Income in an Overlapping Generations Model

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By using an intertemporal equilibrium model with overlapping generations, this paper explores how residence- and source-based taxes on capital income affect the external current account in small open economies. These taxes influence the saving-investment balance not only through their incentive effects on rates of return but also through their impact on the intergenerational distribution of resources. This paper, in its examination of these effects — both intertemporal substitution and intergenerational distribution — identifies the net effect of the various impacts.

1. Introduction

The international integration of financial markets directly influences the macroeconomic implications of capital income taxes. In particular, if capital is internationally mobile, capital income taxes may give rise to substantial international capital and trade flows by impacting the balance between domestic saving and domestic investment. This paper explores the macroeconomic effects of capital income taxes with a special focus on the consequences for the external current account.

Capital income taxes can be levied according to two alternative principles, namely the residence and source principles. Under the residence principle, residents are taxed uniformly on their worldwide capital income, irrespective of the particular jurisdiction where this income

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originates. Residence-based taxes reduce the after-tax return on domestic saving by driving a wedge between the rate of return on world financial markets and the after-tax rate of return received by residents in a particular country. Hence, residence taxes can be interpreted as taxes on the ownership of capital, i.e., saving. Source-based taxes, in contrast, are levied on all capital income that originates in a particular jurisdiction, irrespective of the country of residence of the saver who receives the capital income. These taxes raise the required return on domestic investment above the rate of return on world financial markets. Accordingly, source-based taxes amount to taxes on the location of capital, i.e., investment.

In examining the implications of source-based and residence-based capital income taxes for the external current account, one can employ the identity between, on the one hand, the external current account balance and, on the other hand, the difference between domestic saving and domestic investment. Using this identity, Summers (1988) argues that, in a world with international capital mobility, it is crucial to distinguish between tax policies that primarily affect saving and policies targeted at domestic investment. In particular, policies that reduce saving would initially worsen the external current and trade accounts by boosting short-run consumption. Policies that discourage investment, in contrast, would improve the external accounts initially by weakening domestic demand. This reasoning would suggest important differences between source-based capital income taxes, which increase the required return on domestic investment, and residence-based capital income taxes, which reduce the after-tax return to domestic saving.

The literature has thus recognized that residence- and source-based taxes yield distinct macro-economic implications by generating different effects on the required return on domestic investment and the after-tax return on domestic saving.[1] However, capital income taxes may influence the domestic saving-investment balance not only through their incentive effects on rates of return but also through their impact on the intergenerational distribution of resources. This paper, in its examination of these effects — both intertemporal substitution and intergenerational redistribution — is able to identify the overall macroeconomic effect of the various impacts.

In order to explore these various effects, the paper employs an intertemporal equilibrium model of a small open economy. This model combines, on the one hand, adjustment costs affecting domestic investment and, on the other hand, overlapping generations determining domestic saving. The analysis in this paper reveals that the interaction

[1] See also Sinn (1985) and Slemrod (1988).

between adjustment costs in capital accumulation and the intergenerational distributional effects generated by an overlapping generations structure plays a crucial role in determining the overall macro-economic impact of capital income taxes. The intertemporal equilibrium framework also allows for an integrated analysis of traditional public finance issues, such as efficiency and (intergenerational) equity, and macroeconomic phenomena, such as investment, saving, trade, and capital flows, and the accumulation of net foreign assets and the domestic capital stock. Moreover, the model enables one to explore the role of public debt policy in offsetting the effects of capital income taxes on the intergenerational distribution of resources.

The model differs from numerical studies by presenting analytical solutions that have an intuitive interpretation.[2] The analytical solutions add to economic intuition by explicitly revealing how several major structural parameters affect the transmission of capital income taxes to saving, investment, and the external trade and current accounts. In particular, it identifies the roles of, among others, adjustment costs in investment, the birth rate of new generations, the substitution elasticity in domestic production between capital and labor, and the intertemporal substitution elasticity in consumption. In simulating the entire transition in continuous time, the modeling framework differs from most other analytical studies of open economies, which typically adopt two-period models (see, e.g., Frenkel and Razin, 1986 and 1987, and Wijnbergen, 1986). Compared to two-period models, the continuous-time model allows for a more realistic evaluation of the intertemporal impact of capital-income taxes.

The rest of this paper is structured as follows. Section 2 presents the model. The residence- and source-based taxes are analyzed in Sects. 3 and 4, respectively. Section 5 contains the conclusions.

2. The Model

2.1 Consumption and Saving Behavior

The saving and consumption side of the model consists of an overlapping generations model described by Buiter (1988), which is a combination of a version developed by Yaari (1965) and Blanchard (1984,

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[2] For numerical studies of intertemporal equilibrium models of open economies with international capital mobility, see, e.g., Lipton and Sachs (1983), Mutti and Grubert (1985), Goulder and Eichengreen (1989), Bovenberg and Goulder (1989), and Keuschnigg (1991).

1985) and a version due to Weil (1989). Following the Yaari–Blanchard model, each household faces a constant probability of passing away, θ.[3] In the absence of an operative bequest motive, each household purchases (or sells) an annuity that pays a rate of return, θ. New households that are *not* linked through operative intergenerational transfers to older households are born at a constant rate, $(n + \theta)$.[4] This birth rate measures the heterogeneity, or economic disconnectedness, of the population (see Weil, 1989). Both the total population and labor supply grow at the rate n because all households inelastically supply the same amount of labor.[5] At time $t \geq v$, the representative household of the generation born at time v maximizes the expected value of additive separable utility, adopting a subjective discount rate, δ:

$$U(v,t) = \int_t^{\infty} u\big(c(v,s)\big)\, e^{-\delta(s-t)}\, e^{-\theta(s-t)}\, \mathrm{d}s \tag{1}$$

subject to a budget constraint:

$$\dot{a}(v,t) = (r^* + \theta)a(v,t) + l(t) + w(t) - c(v,t)\,, \tag{2}$$

where $c(v,t)$ and $a(v,t)$ represent, respectively, consumption and financial wealth per capita at time $t \geq v$ of the generation born at time v. A dot above a variable denotes a time derivative. This paper assumes that every living household supplies one unit of homogeneous labor per capita, which pays a wage of $w(t)$, and receives the same lump-sum transfer per capita $l(t)$. Hence, per capita non-capital disposable income (which is the sum of before-tax wages and lump-sum transfers) is age independent. It can be interpreted as the return to human capital and is denoted by $\omega(t) = w(t) + l(t)$. The intertemporal substitution elasticity of consumption is given by the reciprocal of the elasticity of marginal felicity, $\sigma = -cu''(c)/u'(c)$. The domestic economy is assumed to be small relative to the rest of the world. Accordingly, the real rate

[3] One can also interpret this constant probability of death as the probability that a dynasty expires. By allowing for $\theta < 0$, one can allow for intra-dynasty growth.

[4] Weil (1989) interprets this birth rate as the rate at which new dynasties enter the domestic economy. This rate depends on the proportion of newly-born children who are not “loved.”

[5] Hence, the birth rate, $n + \theta$, and the death rate, θ, are distinct in this model. Blanchard (1984, 1985), in contrast, assumes that the birth rate equals the death rate (i.e., $n = 0$), while Weil (1989) abstracts from death (i.e., $\theta = 0$).

of return, r, is fixed by world capital markets. The after-tax rate of return, r^*, is given by

$$r^* = (1 - t_r) r \,, \tag{3}$$

where t_r represents the rate of residence-based tax on capital income. This tax applies uniformly to all returns on financial assets. Hence, interest income, accrued capital gains, and dividends are taxed at the same rate.

The optimization problem yields the following consumption function (see Buiter, 1988):

$$c(v,t) = \Delta[a(v,t) + \bar{h}(t)] \,. \tag{4}$$

$\bar{h}(t)$ represents per capita human wealth at time t, which is identical for all agents alive at t because non-capital income does not depend on age:

$$\bar{h}(t) = \int_t^\infty [\omega(s)]\, e^{-(r^*+\theta)(s-t)}\, \mathrm{d}s \,. \tag{5}$$

Also the propensity to consume out of total wealth, Δ, is age independent because all agents feature the same time horizon:

$$\Delta = r^* + \theta - \frac{r^* - \delta}{\sigma} > 0 \,. \tag{6}$$

This paper assumes that the after-tax return, r^*, exceeds the discount rate. This implies that household consumption is rising over time and that financial wealth is positive.[6]

Following Blanchard (1984, 1985), one can aggregate across generations to arrive at expressions in terms of per capita aggregate variables:

$$C(t) = \Delta[A(t) + H(t)] = \Delta W(t) \,, \tag{7}$$

$$\dot{A}(t) = (r^* - n)A(t) + \omega(t) - C(t) \,, \tag{8}$$

where the per capita aggregate variables are derived from the per capita generation-specific variables as follows:

$$X(t) = \int_{-\infty}^t x(v,t)(n+\theta)\, e^{-(n+\theta)(t-v)}\, \mathrm{d}v \,; \tag{9}$$

$$X = C, A, \qquad x = c, a \,,$$

[6] Bovenberg (1991b) also examines the case $r^* < \delta$.

and $H(t) = \bar{h}(t)$. $W(t) = A(t) + H(t)$ corresponds to per capita aggregate wealth at time t.

2.2 Production and Investment

A neo-classical net production function represents a constant-returns-to-scale technology

$$y = f(k) \ , \tag{10}$$

where y corresponds to output per capita (net of depreciation) of the single tradable commodity and k stands for the capital–labor ratio.[7] The marginal productivity condition for labor represents the demand for labor:

$$w = f(k) - kf'(k) \ , \tag{11}$$

where w represents the before-tax wage rate and $f'(k) = \mathrm{d}f(k)/\mathrm{d}k$. In addition to the production technology (10), the production sector faces a second technology constraint — the installation function. This function was introduced by Uzawa (1969) to model adjustment costs associated with investment.[8] With the labor force growing at the rate n and labor being internationally immobile, this installation function can be written as (see, e.g., Bovenberg, 1986):

$$\dot{k} = k[g(x) - n], \qquad g'(x) > 0, \quad g''(x) < 0 \ , \tag{12}$$

where x is the ratio of net investment to the capital stock. Marginal installation costs rise with the rate of investment, which is reflected in the concavity of the installation function in investment. How rapidly costs increase is mirrored by the elasticity of the marginal productivity of investment σ_x, defined as

$$\sigma_x = -\frac{xg''(x)}{g'(x)} \ . \tag{13}$$

For any given capital stock, the faster the capital stock expands, the more capital goods per additional unit of capital are required. The elasticity σ_x reflects the resource costs of adjusting the domestic capital

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[7] Throughout the rest of this paper, variables are to be understood as dated at time t unless indicated otherwise.

[8] Following Lucas (1967), Summers (1981) models adjustment costs in an alternative way. His formulation, however, leads to similar results for the optimal investment rule.

stock. In an open-economy framework, this elasticity provides a measure for the degree of international mobility of the physical capital stock. A lower elasticity corresponds to a higher degree of international mobility of physical capital. In the short run, the physical capital stock is fixed. Hence, physical capital is immobile initially. In the long run, in contrast, physical capital is internationally perfectly mobile.

Firms are equity financed and maximize the present value of their after-tax cash flow subject to the installation function:

$$V = \int_0^\infty \left[(1-t_k)(f(k)-w) - xk\right] e^{-(r-n)t}\, \mathrm{d}t\ , \tag{14}$$

where t_k stands for the rate of source-based[9] tax on capital income.[10] Optimization gives rise to the following optimal path for the shadow price of capital, q:

$$\frac{\dot{q}}{q} = r - g(x) - \frac{(1-t_k)f'(k)}{q} + \frac{x}{q} \tag{15}$$

and the implicit demand function for investment

$$qg'(x) = 1\ . \tag{16}$$

2.3 Government

The overlapping generations model causes Ricardian equivalence to fail. Accordingly, the intertemporal equilibrium is affected by how the government distributes the revenues from capital income taxes across (disconnected) generations. This paper assumes that the government distributes the additional tax revenues in a way that is distributionally neutral. In particular, every living household receives a constant

[9] The corporate income tax is mainly source based. In particular, the corporate tax system in the host country (i.e., the country where the investment occurs) determines the effective corporate tax rate on marginal investment if foreigners finance these investments through portfolio capital flows. Even in the case of direct investments, the corporate tax may be effectively source based, for example, if the residence country has a territorial system of corporate taxation.

[10] The tax is assumed to be assessed on income net of true economic depreciation.

and uniform lump-sum transfer per capita. This transfer can also be interpreted as a subsidy to labor because per capita labor supply is age-independent and inelastic. The public budget constraint determines the magnitude of the constant (per-capita) lump-sum transfer:

$$\dot{B} = (r - n)B + l - t_k k f'(k) - t_r r A \ , \tag{17}$$

where B represents public debt per capita.

If one combines the public budget constraint (17) with the aggregate budget constraint of private households (8) and the accumulation equations for the value of the physical capital stock [from (12) and (15)], one arrives at the budget constraint for the country as a whole:

$$\dot{F} = (r - n)F + TB \ , \tag{18}$$

where F denotes net foreign assets per capita:

$$F = A - B - kq \tag{19}$$

and TB represents the external trade balance, which amounts to the difference between domestic supply of and aggregate domestic demand for commodities:

$$TB = f(k) - xk - C \ . \tag{20}$$

Expression (18) can be interpreted as the definition of the growth-adjusted external current account. It states that the accumulation of net foreign assets per capita is equal to the sum of growth-adjusted net capital income received from abroad, $(r - n)F$, and the external trade balance, TB.

2.4 The Model Solution

This paper explores the local behavior of the small open economy around the initial steady state by log-linearizing the model around the initial balanced growth path.[11] Unless otherwise indicated, a tilde, $\tilde{}$, above a variable stands for the change in this variable relative to its initial steady-state value. As regards the two tax rates, tildes are defined as follows:

$$\tilde{t}_i = \frac{\mathrm{d}(1 - t_i)}{(1 - t_i)} < 0, \qquad i = k, r \ . \tag{21}$$

[11] For similar approaches, see, e.g., Judd (1985) and Bovenberg (1986).

In the initial steady state, domestic residents own the entire domestic capital stock. Furthermore, the tax rates as well as public debt are zero on the initial balanced growth path. Hence, $r = r^*$, $l = 0$, and $\omega = w$ in the initial steady state. The two policies examined here are unanticipated and permanent and are implemented at $t = 0$.

The increases in the residence- and source-based taxes are normalized so that they yield the same rise in lump-sum transfers. Log-linearizing the budget constraint of the government (17), one finds the following relationships between the exogenously-given increase in lump-sum transfers as a ratio of initial net domestic income, $\tilde{l}$, and the required changes in the tax rates:

$$\tilde{l} = \alpha_k(-\tilde{t}_k) + (1 - \alpha_k)\left(\frac{A}{\omega}\right)(-r\tilde{t}_r)\,, \tag{22}$$

where α_k represents the share of net capital income in net national income. With zero initial tax rates, public debt is not used and $B = 0$ at all times.

The model is solved recursively. First, the log-linearized investment model yields the time paths for the capital stock, the shadow price of capital, investment, and before-tax wages (see Appendix A). Combining these solutions with the government budget constraint, one derives the development of after-tax wages (see Appendix A), which is used to solve the saving side of the model (see Appendix B).

3. A Residence-based Tax

A residence-based tax imposed by a small open economy does not affect domestic investment because it does not drive a wedge between the required return on domestic investment and the fixed rate of return on world financial markets.[12] Accordingly, the macroeconomic implications of a residence-based tax originate in the effects of the tax on saving and consumption behavior. In particular, the tax impacts saving through two channels: first, the intergenerational distribution of resources and, second, intertemporal substitution of consumption due to a lower after-tax return on domestic saving.

[12] If the tax rate on interest income differs from that on dividends and capital gains, a change in the residence-based tax rate on interest income would generally affect domestic investment (see, e.g., Nielsen and Sørensen, 1991).

3.1 The Intergenerational Distribution

By reducing the after-tax return on financial wealth, a residence-based tax on capital income harms the owners of financial capital. Human capital, in contrast, benefits because the rate used to discount labor earnings declines, while the revenues from the residence-based tax are used to supplement labor earnings. The higher real value of human capital implies that the generations who are born after the residence-based tax is introduced gain. These generations start their lives without any financial capital and, therefore, depend entirely on labor earnings. Accordingly, the relative change in real wealth of the generations born at time $t \geq 0$, $\tilde{W}^*(t)$, corresponds to the relative change in real human wealth, $\tilde{H}^*(0)$, which is given by (see Appendix C):

$$\tilde{W}^*(t) = \tilde{H}^*(0) = (r - n)\left(\frac{A}{\omega}\right)\frac{(-r\tilde{t}_r)}{\Delta} . \tag{23}$$

The (older) generations that are alive at the time the policy shock occurs are affected not only by changes in human wealth but also by changes in financial wealth. The overall effect on the real wealth position of these generations, $\tilde{W}^*(0)$,[13] is given by (see Appendix C):

$$\tilde{W}^*(0) = -h^*\left(\frac{A}{\omega}\right)\frac{(-r\tilde{t}_r)}{\Delta} = -\frac{1}{a_c}\left(\frac{n+\theta}{r+\theta}\right)\tilde{\iota} , \tag{24}$$

where a_c stands for the initial share of consumption in net national income and h^* is defined as:

$$h^* = n + \theta - \frac{r - \delta}{\sigma} > 0 . \tag{25}$$

Hence, on average, current generations lose because the fall in financial wealth more than offsets the rise in real human wealth. The birth rate, $n + \theta$, is a major determinant of the intergenerational distributional effect. As the birth rate increases, the population becomes more heterogeneous. Hence, the current generations internalize less and less the higher value of human wealth and suffer a larger loss in real wealth.

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[13] This effect is the weighted average of the welfare effects for generations with different ages. The older generations bear the heaviest burden because they own the most financial wealth. The youngest generations, who depend mainly on human wealth, may actually benefit from a residence-based tax.

3.2 Economy-wide Consumption

The time path for aggregate consumption is characterized by three elements: the short-run and long-run changes in consumption and an adjustment speed, h^* (see Appendix B):

$$\tilde{C}(t) = \tilde{C}(0)\, e^{-h^* t} + \tilde{C}(\infty)(1 - e^{-h^* t}) \,, \tag{26}$$

$$\tilde{C}(0) = \frac{1}{\sigma} \frac{(\delta + \theta)}{(r + \theta)} \frac{(-r\tilde{t}_r)}{\Delta} \,, \tag{27}$$

$$\tilde{C}(\infty) = -\frac{(r - n)}{h^*} \frac{1}{\sigma} \frac{(\delta + \theta)}{(r + \theta)} \frac{(-r\tilde{t}_r)}{\Delta} \,. \tag{28}$$

A residence-based tax unambiguously raises consumption initially. The larger the intertemporal substitution elasticity, $(1/\sigma)$, the larger the initial boost to consumption. Intuitively, a higher intertemporal substitution elasticity renders consumption more sensitive to the lower after-tax rate of return. Following the initial rise, consumption starts to drop off and in the new steady state it has declined to a level below its initial steady-state value. The adjustment speed h^* corresponds to the absolute value of the stable root of the linearized saving system (see Appendix B). Expression (25) reveals that this adjustment speed is closely related to the birth rate. The higher the birth rate, the faster consumption converges toward its long-run equilibrium value.

3.3 Trade Balance and Net Foreign Assets

The effects on the trade balance can be written as the difference between domestic supply of and domestic demand for commodities [see also (20)]:

$$\tilde{TB} = \tilde{y} - a_c\tilde{C} - a_I(\tilde{x} + \tilde{k}) \,. \tag{29}$$

Here, $\tilde{TB}$ stands for the change in the trade balance relative to initial net domestic income and a_I denotes the net income share of net investment in the initial steady state. Capital accumulation determines domestic supply according to:

$$\tilde{y} = \alpha_k \tilde{k} \,. \tag{30}$$

The residence-based tax impacts the trade balance only through its effect on consumption because it leaves investment demand and capital accumulation unaffected. Accordingly, the initial boost to domestic consumption worsens the trade balance in the short run. In the long run, however, the trade balance improves on account of lower consumption demand.

The consequences for net foreign assets are derived by subtracting the value of the domestic capital stock from financial assets owned by domestic households [see also (19) with $B = 0$]:

$$\tilde{F} = \tilde{A} - z(\tilde{q} + \tilde{k}) . \tag{31}$$

Here, $z = \alpha_k - a_I \geq 0$ is the share of the cash flow of firms in (net) domestic income. $\tilde{F}$ and $\tilde{A}$ are defined as:

$$\tilde{X} = (r - n)\frac{\mathrm{d}X}{y}; \qquad X = F, A . \tag{32}$$

Since the residence-based tax does not affect the value of the domestic capital stock, the effect on the foreign asset position, $\tilde{F}$, corresponds to the effect on domestic financial wealth, $\tilde{A}$. The time path for net financial wealth is given by (see Appendix B):

$$\tilde{F}(t) = \tilde{A}(t) = \tilde{A}(\infty)(1 - e^{-h^* t}) , \tag{33}$$

where

$$\tilde{A}(\infty) = a_c \tilde{C}(\infty) . \tag{34}$$

The development over time of the ratio of net foreign assets to domestic income yields the effect on the growth-adjusted external current account balance [see also (18)]:

$$\frac{\dot{\tilde{F}}}{r - n} = \tilde{F} + \tilde{TB} . \tag{35}$$

The residence-based tax unambiguously reduces saving, thereby worsening the external current account and negatively affecting net foreign assets. The magnitude of these effects depends importantly on the intertemporal elasticity of substitution.

3.4 Neutralizing the Effects on the Intergenerational Distribution

The initial positive response of consumption is the result of, on the one hand, a positive substitution effect due to the lower after-tax return, and, on the other hand, a negative income effect that originates in the redistribution away from the current generations. The government can actually neutralize the intergenerational distributional effects of the tax by employing public debt policy so that only the intertemporal substitution effect remains.

In order to leave the intergenerational distribution unaffected, the government provides a one-time subsidy to the owners of financial wealth at the time the unanticipated policy shock occurs. This subsidy should be debt-financed and should offset the windfall loss suffered by capitalists.[14] Accordingly, the initial jump in public debt corresponds to the worsening of the real wealth position of the owners of financial capital (see Appendix C):

$$\tilde{B}(0) = a_\omega (r-n)\left(\frac{A}{\omega}\right)\frac{(-r\tilde{t}_r)}{\Delta} = \frac{(r-n)}{(r-n+h^*)}\tilde{l}\ , \tag{36}$$

where $a_\omega = 1 - \alpha_k$ denotes the share of (after-tax) labor earnings in net domestic income. $\tilde{B}$ is defined in analogy of $\tilde{F}$ and $\tilde{A}$ as:

$$\tilde{B} = (r-n)\frac{\mathrm{d}B}{y}\ . \tag{37}$$

In order to meet its budget constraint, the government reduces per capita transfers.[15] The public budget constraint is given by:

$$\dot{\tilde{B}}(t) = (r-n)\tilde{B}(t) + (r-n)\tilde{l}^*(t)\ . \tag{38}$$

Here, $\tilde{l}^*$ stands for the ratio of the change in lump-sum transfers that is required to service the public debt to net domestic income in the initial steady state. By using Laplace transforms, one can write the public budget constraint as:[16]

$$\tilde{B}(0) = -(r-n)L_{\tilde{l}^*}(r-n)\ . \tag{39}$$

[14] Essentially, this policy amounts to exempting the initial stock of financial wealth from the residence-based tax and shifting the revenues from taxing the return on new saving forward in the form of higher debt-financed transfers. Transfers are increased before tax revenues accrue in order to compensate the older generations for the lower return on their (new) saving.

[15] This policy can also be interpreted as an increase in taxes on labor because per capita labor supply is exogenous and independent of age.

[16] The Laplace transform of $G(t)$ is $L_G(s)$, with $L_G(s) = \int_0^\infty e^{-st}G(t)\,\mathrm{d}t$. Intuitively, the Laplace transform of $G(t)$ is the present value of the flow $G(t)$ discounted at s.

In order to have all generations share equally in the cost of servicing the stock of public debt, the government chooses a constant path of transfers that meets (39):

$$\tilde{l}^* = -\tilde{B}(0) = -\left(\frac{r-n}{r-n+h^*}\right)\tilde{l}\,. \tag{40}$$

This path for transfers implies that the ratio of public debt to income remains constant after its initial rise. Furthermore, the lower transfers exactly offset the positive effect of the residence-based tax on the real wealth position of human capital.

The combination of this public debt policy and the residence-based tax yields the following path for aggregate consumption:

$$\tilde{C}(t) = \tilde{C}(0)\, e^{-h^* t} + \tilde{C}(\infty)(1 - e^{-h^* t})\,, \tag{41}$$

$$\tilde{C}(0) = \frac{1}{\sigma}\frac{(-r\tilde{t}_r)}{\Delta}\,, \tag{42}$$

$$\tilde{C}(\infty) = -\frac{r-n}{h^*}\,\frac{1}{\sigma}\,\frac{(-r\tilde{t}_r)}{\Delta}\,. \tag{43}$$

It appears from comparing this time path with that given by (26), (27), and (28), that the fluctuations in aggregate consumption are largest if the intergenerational distributional effects are eliminated. The reason is that the intergenerational distributional effects of a residence-based tax favor future generations at the expense of current generations. Hence, these income effects weaken the substitution effects of a lower after-tax return because they reduce initial consumption and boost long-run consumption.

3.5 Neutralizing the Intertemporal Substitution Effects

The government can neutralize not only the income effects but also the intertemporal substitution effects of the tax. In particular, it can continue to tax the return on financial capital but at the same time allow a tax deduction for new saving. This policy experiment, in fact, effectively substitutes a destination-based consumption tax for a labor tax. Although this policy does not involve any intertemporal substitution effects, it does exert macroeconomic effects because it impacts the intergenerational distribution. In particular, it implies a capital levy on existing financial wealth and, therefore, a wealth transfer from older to younger generations.[17] Hence, consumption falls in the short run but rises in the long run. The trade balance improves initially and the economy accumulates additional financial assets in the form of net foreign assets.

4. A Source-based Tax

4.1 Investment and Capital Accumulation

A source-based tax on capital income affects not only domestic saving but also domestic investment. The investment system yields the following time path for the capital–labor ratio (see Appendix A):

$$\tilde{k}(t) = \tilde{k}(\infty)(1 - e^{-ht}) . \tag{44}$$

h stands for the rate at which the capital intensity of production converges to its new steady-state value:

$$\frac{h}{r-n} = -\frac{1}{2} + \sqrt{\frac{1}{4} + \frac{\alpha_k \cdot a_I(1-\alpha_k)}{\sigma_x \cdot \sigma_k \cdot z^2}} . \tag{45}$$

A less concave installation function, which reflects more elastic investment, yields a higher adjustment speed. The adjustment speed approaches infinity if adjustment costs are absent (i.e., $\sigma_x = 0$). This case corresponds to perfectly mobile physical capital. The case of a fixed factor, in contrast, is represented by a zero adjustment speed.

The long-run effect on the domestic capital stock, $\tilde{k}(\infty)$, is given by:

$$\tilde{k}(\infty) = -\left(\frac{\sigma_k}{1-\alpha_k}\right)(-\tilde{t}_k) . \tag{46}$$

Accordingly, source-based taxes reduce the domestic capital stock. The substitution elasticity between capital and the immobile factor (i.e., labor), σ_k, is an important determinant of the adverse effect on capital accumulation. The larger this elasticity, the less sensitive the marginal productivity of capital is with respect to the capital–labor ratio and therefore the more this ratio has to fall to raise the after-tax return of capital to the exogeneous level in the rest of the world.

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[17] See Bovenberg (1991b). Auerbach and Kotlikoff (1987) examine these effects on the intergenerational distribution in a closed-economy framework.

4.2 The Intergenerational Distribution

The impact on the intergenerational distribution depends importantly on how the source tax affects after-tax labor earnings over time. If the government does not adopt debt finance, after-tax labor earnings develop as follows:

$$\tilde{\omega}(t) = \tilde{\omega}(0)\, e^{-ht} , \tag{47}$$

$$a_\omega \tilde{\omega}(0) = -\alpha_k \tilde{t}_k . \tag{48}$$

Initially, net labor earnings rise as the budgetary revenues from the capital income tax allow for larger transfers to labor. Over time, however, the gradual decline in the capital intensity of production reduces the marginal productivity of labor, thereby negatively affecting before-tax wages. Accordingly, following their initial rise, labor earnings start to fall. In the long run, labor earnings return to their initial steady-state level. Intuitively, capital can shift the entire long-run burden of the source-based tax to labor because physical capital is perfectly mobile in the long run. Indeed, in the long run a source-based tax on capital income constitutes an implicit tax on labor. Hence, a source-based tax on capital income that is returned as a transfer to labor does not affect after-tax labor earnings.

The effect on human wealth of the generations who are alive at the time of the policy shock, $\tilde{H}(0)$, is computed by discounting the path of after-tax wages by the sum of the rate of return on financial capital and the probability of death:

$$a_\omega \tilde{H}(0) = \left(\frac{r+\theta}{h+r+\theta}\right)(-\alpha_k \tilde{t}_k) . \tag{49}$$

A source-based tax raises the value of human capital. Human capital benefits most if sluggish capital decumulation causes before-tax wages to fall only slowly (i.e., h is small) and if the long-run changes in after-tax wages are discounted relatively heavily (i.e., $r+\theta$ is large). In that case, the eventual fall in before-tax wages occurs largely beyond the horizons of the currently alive.

The consequences for real wealth of the generations born at time $t \geq 0$, $\tilde{H}(t)$, are given by:

$$\tilde{H}(t) = \tilde{H}(0)\, e^{-ht} . \tag{50}$$

Accordingly, the time path of after-tax earnings is the only determinant of the welfare position of generations that are born after the policy shock hits. Intuitively, these generations start their life without any financial capital and, therefore, depend entirely on labor income. The generations who are born immediately after the policy shock occurs gain most because they suffer least from lower before-tax wages on account of less capital-intensive production.

The welfare position of the older generations living at the time of the unanticipated policy shock is affected not only by the impact on human wealth but also by that on financial capital. The initial consequences for the value of financial capital indicate whether capitalists can shift the source-based tax:

$$\tilde{A}(0) = z\tilde{q}(0) = -\left(\frac{r-n}{r-n+h}\right)(-\alpha_k \tilde{t}_k) \,. \tag{51}$$

The magnitude of the capital loss that is suffered by capitalists depends on the ratio of the adjustment speed, which is a measure of the international mobility of physical capital, and the effective discount rate $(r-n)$. The faster the capital–labor ratio falls, the more capital is able to shift the tax burden to labor. In fact, capital escapes the burden entirely if physical capital is internationally perfectly mobile (i.e., $h \to \infty$).

The consequences for the real wealth position of the current generations[18] are found by combining the effects on human and financial capital [expressions (50) and (51), respectively] and using (22) with $\tilde{t}_r = 0$ to write $\tilde{t}_k$ in terms of the transfer $\tilde{l}$:

$$a_c\tilde{W}(0) = -\left(\frac{n+\theta}{r+\theta+h}\right)(-\alpha_k\tilde{t}_k) = -\left(\frac{n+\theta}{r+\theta+h}\right)\tilde{l} \,. \tag{52}$$

A source-based tax harms current generations due to the redistribution away from capital to labor. Intuitively, current generations suffer a decline in real wealth because they own the entire domestic capital stock and, therefore, fully absorb lower capital earnings. However, they do not fully internalize higher transfers to labor as these transfers do, in part, accrue to future generations.

Current generations suffer most if the rate of birth, $n+\theta$, is high and capital decumulation occurs only slowly (i.e., h is small). A low speed of capital decumulation causes capital earnings to rise only slowly after their initial fall, thereby depressing discounted capital earnings, which

[18] How the tax impacts the welfare of currently alive generations with different ages depends on how the ownership of the domestic capital stock is distributed across different age groups when the policy shock occurs.

accrue to the currently alive. A high birth rate implies that the currently alive absorb only a small part of the higher return to human capital.

Comparing this wealth effect (52) with that from the residence tax (24), one finds that current generations suffer most from a residence-based tax unless adjustment costs are infinite (i.e., $h = 0$). Intuitively, if physical capital is not completely immobile (i.e., $h > 0$), current generations can escape more from the burden of a source-based tax than under a residence-based tax on account of the international mobility of physical capital.

4.3 Consumption and Saving

The source-based tax impacts consumption and saving because it affects the intergenerational distribution of resources. The time path for aggregate consumption is given by (see Appendix B):

$$\tilde{C}(t) = \tag{53}$$

$$\tilde{W}(0)\, e^{-h^* t} + h^* \left(\frac{r+\theta}{r+\theta+h} \right) \tilde{\omega}(0) \left(\frac{e^{-ht} - e^{-h^* t}}{h^* - h} \right) ,$$

where $\tilde{W}(0)$ is given by (52). The time path of consumption is non-monotonic. In particular, consumption falls initially on account of the worsening wealth position of the currently alive. Following its initial fall, however, consumption starts to recover. Intuitively, the development of consumption at each point in time depends on the relationship between the welfare of generations that are being born and the older generations. Economy-wide consumption rises if and only if newly-born generations are wealthier than the preceding generations. The generations that are born immediately after the tax is introduced benefit from higher human wealth and, in contrast to older generations, do not suffer from lower capital earnings because they were not alive at the time the unanticipated policy shock occurred. Hence, the younger generations are better off than the older ones and consumption rises when they enter the population. A high rate of birth, $n + \theta$, causes consumption to recover rapidly because it implies that the young generations, that benefit from the tax on capital income, rapidly constitute a large part of the population. When the older generations that were alive when the tax was introduced have become a sufficiently small part of the population, consumption rises above its initial steady-state level.

Eventually, however, consumption starts to decline and, on the new balanced growth path, it falls back to its initial steady-state value. The eventual fall in consumption is due to the declining trend in labor income. Near the new steady state, almost all living generations have been born after the tax was reduced. At that time, therefore, changes in human wealth are the major determinants of the relative wealth positions of the older and newly-born generations. Near the new balanced growth path, older generations are better off than younger generations because the older generations benefit from higher human wealth, as per capita labor incomes are falling over time. Hence, consumption declines in the long run.

How large the fluctuations in consumption are depends importantly on the magnitude of the effects on intergenerational distribution. The larger the adjustment costs (and the lower the adjustment speed of capital decumulation) and the birth rate are, the more substantial the redistribution across generations is and, therefore, the larger the swings in aggregate consumption become. Intuitively, the adjustment costs produce the distributional effects between capital and labor. A positive birth rate translates these effects on the functional distribution of resources into consequences for the distribution across generations. Accordingly, it is the interaction between non-zero adjustment costs and overlapping generations that gives rise to the effects on consumption. Indeed, consumption would remain constant at its initial steady-state level if either adjustment costs would be absent (i.e., $h \to \infty$) or households would internalize the welfare of their offspring (i.e., $n + \theta = 0$).

4.4 Trade Balance and Net Foreign Assets

A source-based tax impacts the trade balance through three channels: consumption and investment demand and the effect of domestic capital decumulation on the domestic supply of commodities. Substituting the expressions for capital accumulation and investment as well as the results for economy-wide consumption (53) into the definition of the trade balance (29), one derives for the initial trade balance response, which corresponds to the initial effect on the external current account:

$$\tilde{TB}(0) = \left(\frac{h}{r-n}\right) z \frac{\sigma_k}{1-\alpha_k}(-\tilde{t}_k) + \left(\frac{n+\theta}{r+\theta+h}\right)(-\alpha_k \tilde{t}_k) . \quad (54)$$

In the short run, demand effects determine the trade balance response. The reason is that domestic supply is fixed initially because labor supply is exogenous, while the physical capital stock is fixed in the short run on account of adjustment costs. It appears from (54) that a source-based tax unambiguously improves the trade balance in the short run. This initial improvement is due not only to weaker investment demand but also to a fall in initial consumption demand, reflecting a stronger saving performance. The effect of lower investment demand on domestic absorption is represented by the first term at the right-hand side of (54). The second term represents the positive saving effect of the source-based tax due to the intergenerational distributional effect. In particular, a source-based tax raises economy-wide saving because it benefits future generations at the expense of the currently alive.

After the trade balance improves initially, the improvement falls off because of two reasons. First, domestic per capita supply declines on account of a lower capital–labor ratio. Second, consumption demand recovers (see above). The trade balance eventually deteriorates relative to the initial steady state. Intuitively, the dynamics of the trade balance reflect both the demand and supply effects of lower investment. The negative demand effects dominate in the short run and the trade balance improves. In the long run, the trade balance worsens due to adverse supply effects. In the long run, the net foreign asset position improves. The increased net investment income received from abroad that corresponds to the improved foreign asset position allows the small open economy to afford a weaker trade balance in the long run.

4.5 Neutralizing the Effects on the Intergenerational Distribution

Just as in the case of the residence-based tax, the government can neutralize the intergenerational distributional effects of a source-based tax by employing public debt policy. In particular, at the time the unanticipated tax is implemented, it should provide a one-time wealth subsidy. This subsidy should be debt financed and should exactly offset the windfall losses suffered by capitalists (51):

$$\tilde{B}(0) = \left(\frac{r-n}{r-n+h}\right)(-\alpha_k \tilde{t}_k) \,. \tag{55}$$

In order to confront all generations with the same absolute change in (ex ante or expected) welfare per capita, the government should aim at constant per capita labor earnings, ω, over time. The time path for transfers that meets both this condition and the intertemporal public budget constraint (39) is:

$$\tilde{l}^*(t) = -(-\alpha_k \tilde{t}_k)\, e^{-ht} = -\tilde{l}\, e^{-ht} \,. \tag{56}$$

4.6 Neutralizing the Effects on the Required Return on New Investment

The government can neutralize the effect of the source-based tax on investment behavior by allowing firms to expense their new investment spending from their capital income tax liability. A source-based tax combined with an immediate write-off for investment amounts to a tax on the cash flow of domestic firms. Just as a destination-based consumption tax does not affect the incentive to save for each individual household, so does a cash-flow tax on investment leave the incentive to invest unaffected.[19] However, both the destination-based consumption tax and the source-based cash-flow tax imply a capital levy on old capital. A destination-based consumption tax amounts to a capital levy on the stock of financial capital owned by domestic residents, while a source-based cash-flow tax implies a wealth tax on the owners of the domestic capital stock. Just as the destination-based consumption tax, the cash-flow tax harms current generations. This gives rise to macroeconomic effects. In particular, the cash-flow tax improves the trade balance in the short run as consumption demand falls. In the long run, a larger stock of foreign assets allows the economy to run a larger trade deficit corresponding to a higher level of domestic demand.

5. Conclusions

This paper explored the macroeconomic implications of residence- and source-based taxes on capital income in small open economies. The analysis revealed that the two alternative types of capital income taxes yield different effects on domestic demand and the external accounts. This reflects the differential impacts of these taxes not only on the required return on investment and the after-tax return on saving, but also on the intergenerational distribution. Whereas a residence-based tax depresses the return on domestic saving, a source-based tax raises the required return on domestic investment. Furthermore, capital income taxes benefit younger generations at the expense of older generations, who own the stock of financial wealth. Although it typically imposes the heaviest burden on existing generations, a residence-based tax nevertheless boosts initial consumption and depresses economy-wide saving on account of the intertemporal substitution effect associated with a

[19] In other words, the cash-flow tax yields a zero effective tax rate on investment. For an analysis of the macro-economic effects, see Bovenberg (1991b).

lower after-tax return on saving. Accordingly, the substitution effect dominates the income effect and the trade balance worsens in the short run. In the long run, a smaller stock of foreign assets requires a stronger trade performance.

A source-based tax improves the initial trade performance by reducing investment and raising saving. Accordingly, larger saving on account of the intergenerational distributional effects strengthens the effects of weaker investment demand on the short-run trade balance. Investment falls because a source-based tax raises the required return on physical capital located domestically. Saving rises as a result of the intergenerational redistribution of resources away from current to future generations. In the long run, the trade performance worsens, as a smaller capital stock reduces domestic supply and as richer younger generations imply a higher level of consumption demand.

The analytical solutions reveal how various structural parameters impact the macroeconomic consequences of capital income taxes. In particular, a higher birth rate generates larger effects on the intergenerational distribution. The intertemporal substitution elasticity of consumption is an important determinant of the negative saving effects that are induced by a residence-based tax. The magnitude of the adverse investment effects of a source-based tax depends importantly on both the substitution elasticity between capital and labor in production and the adjustment costs in investment.

The model in this paper could be extended in several directions. Introducing endogenous labor supply would allow one to trade off labor–leisure distortions with distortions in the capital market. Sørensen (1990) introduces endogenous labor supply in an overlapping generations model that does not include adjustment costs in investment. The model also assumes that commodities are perfect substitutes. Hence, trade flows are perfectly elastic. Several studies suggest that the introduction of several commodities that are imperfectly substitutable may reduce the impact of policy shocks on net capital flows and the external accounts (see, e.g., Murphy, 1986; Engel and Kletzer, 1989; and Bovenberg, 1989). Intuitively, intratemporal trade in commodities needs to effect the resource transfers implicit in intertemporal trade. If commodities become less substitutable, this becomes more difficult and relative prices (such as the real exchange rate and the terms of trade) rather than international capital and trade flows absorb more of the adjustment.

In practice, one rarely finds pure residence-based or source-based taxes on capital income. In particular, capital income taxes typically discriminate across various forms of financing (see, e.g., Sinn, 1987). Nielsen and Sørensen (1991) incorporate various financing options within the modeling framework used in this paper while assuming that all equity in domestic firms is held by domestic residents. They examine the effect of corporate taxes, which amount to source-based taxes on equity income, capital gains taxes, dividend taxes, and taxes on interest income. Their analysis could be extended to allow for foreign direct investment.

Appendix A: The Investment System

The investment system is found by log-linearizing (12) and (15) and substituting the log-linearized version of (16) to eliminate $\tilde{x}$. In order to express the elasticities in observable shares, one substitutes the following steady-state relationships [which follow from (12) and (15)]:

$$g(x) = n\ , \tag{A.1}$$

$$(r-n)\frac{qk}{f(k)} = z = \alpha_k - a_I\ . \tag{A.2}$$

This yields the following two-dimensional investment system:

$$\begin{bmatrix} \dot{\tilde{k}} \\ \dot{\tilde{q}} \end{bmatrix} = (r-n) \begin{bmatrix} 0 & \dfrac{a_I}{\sigma_x z} \\ \left(\dfrac{\alpha_k}{z}\right)\left(\dfrac{1-\alpha_k}{\sigma_k}\right) & 1 \end{bmatrix} \begin{bmatrix} \tilde{k} \\ \tilde{q} \end{bmatrix} + \begin{bmatrix} 0 \\ -\dfrac{\alpha_k}{z} \end{bmatrix} [\tilde{t}_k]\ , \tag{A.3}$$

where we have used the definition of σ_k:

$$\sigma_k = -\left(\frac{f'(k)}{f''(k)k}\right)(1-\alpha_k)\ . \tag{A.4}$$

The long-run solution for the *capital–labor ratio* (46) is derived by setting the left-hand side of (A.3) equal to zero and solving for $\tilde{k}(\infty)$. Expression (45) for *the adjustment speed* h is computed as the absolute value of the stable (i.e., negative) root of the first elasticity matrix at the right-hand side of (A.3).

The initial jump of *the value of the domestic capital stock*, $\tilde{q}(0)$, is found by substituting the solution for the capital–labor ratio [from (44) and (46)] into the first row of (A.3). The changes in *after-tax labor earnings* due to a source-based tax are derived by substituting (11) into (17) (with $B = 0$) to eliminate w and log-linearizing the resulting equation (with $\tilde{t}_r = 0$):

$$a_\omega \tilde{\omega} = \alpha_k \left\{ \frac{1-\alpha_k}{\sigma_k} \right\} \tilde{k} - \alpha_k \tilde{t}_k \ , \qquad \text{(A.5)}$$

where (A.4) has been used. Expressions (47) and (48) are derived from (A.5) by substituting the time-path for the capital–labor ratio [from (44) and (45)].

The relative change in *human wealth* (49) follows from log-linearizing the definition of human wealth:

$$H(t) = \int_t^\infty \omega(s)\, e^{-(r^*+\theta)(s-t)}\, \mathrm{d}s \qquad \text{(A.6)}$$

according to:

$$\tilde{H}(0) = (r^* + \theta) \int_0^\infty \tilde{\omega}(t)\, e^{-(r^*+\theta)t}\, \mathrm{d}t - \frac{r^*}{r^* + \theta} \tilde{t}_r \ . \qquad \text{(A.7)}$$

Substituting (47) and (48) into (A.7) and setting $\tilde{t}_r = 0$ and $r^* = r$, one finds (49).

Appendix B: The Saving System

The saving system consists of two dynamic equations in aggregate consumption, C, and financial wealth, A. The dynamic equation for consumption is found by differentiating (7) with respect to time and substituting (8) and the time derivative of (A.6). This yields:

$$\dot{C}(t) = \left(\frac{r^* - \delta}{\sigma} \right) C(t) - \Delta(n + \theta) A(t) \ . \qquad \text{(B.1)}$$

The dynamic equation for financial wealth is derived from (8) and using (3), $\omega(t) = w(t) + l(t)$, and (17) (with $\dot{B} = B = 0$) in order to eliminate ω:

$$\dot{A}(t) = (r - n) A(t) + \omega_I(t) - C(t) \ , \qquad \text{(B.2)}$$

where:

$$\omega_I(t) = w(t) + t_k f'(k) k \ . \qquad \text{(B.3)}$$

The saving system is solved by using Laplace transforms. The Laplace transform, $L_p(s)$, of a function $p(t)$ is defined by:

$$L_p(s) = \int_0^\infty e^{-st} p(t)\,\mathrm{d}t\,. \tag{B.4}$$

The Appendix uses the following expression for the Laplace transform of the time derivative of a function $p(t)$:

$$L_{\dot{p}}(s) = \int_0^\infty e^{-st} \dot{p}(t)\,\mathrm{d}t = sL(s) - p(0)\,. \tag{B.5}$$

Taking the Laplace transforms of the log-linearized versions of (B.1) and (B.2), and using (B.5), one can solve for the Laplace transforms of consumption and financial wealth according to:

$$D(s)\begin{bmatrix} L_{\tilde{C}}(s) \\ L_{\tilde{A}}(s) \end{bmatrix} = \tag{B.6}$$

$$= \begin{bmatrix} s-(r-n) & -\dfrac{(n+\theta)\Delta}{a_c(r-n)} \\ -(r-n)a_c & s-\left(\dfrac{r-\delta}{\sigma}\right) \end{bmatrix} \begin{bmatrix} \tilde{C}(0) + \dfrac{1}{s}\dfrac{\theta+\delta}{\sigma\Delta} r\tilde{t}_r \\ a_\omega(r-n)L_{\tilde{\omega}_I}(s) + \tilde{A}(0) \end{bmatrix},$$

where $r = r^*$ is used to rewrite the elasticities, as the residence-based tax is zero in the initial steady state. The time path for after-tax labor earnings, $\tilde{\omega}_I(t)$, is derived from the investment system by substituting (11) into (B.3), log-linearizing, and substituting the solution for capital accumulation [from (44) and (46)]. The determinant $D(s)$ of the elasticity matrix is defined by:

$$D(s) = \{s - (r+\theta)\}(s + h^*)\,. \tag{B.7}$$

The short-run change in financial wealth, $\tilde{A}(0)$, is taken from the investment system by using $\tilde{A} = z\tilde{q}$. To pin down the *initial change in consumption*, $\tilde{C}(0)$, one uses the condition that $L_{\tilde{C}}(r+\theta)$ is bounded.[20] This implies that the first row of the right-hand side of (B.6) should be zero, which gives rise to:

$$\frac{a_c}{\Delta}\left[\tilde{C}(0) + \frac{1}{\sigma}\frac{(\delta+\theta)}{(r+\theta)}\frac{r\tilde{t}_r}{\Delta}\right] = \frac{\tilde{A}(0)}{(r-n)} + a_\omega L_{\tilde{\omega}_I}(r+\theta)\,. \tag{B.8}$$

[20] See, e.g., Judd (1982). This paper explains the use of Laplace transforms to solve for log-linearized perfect-foresight models.

(B.8) yields (27) because $\tilde{\omega}_I = \tilde{A}(0) = 0$ in case the residence-based tax is introduced.

The long-run solutions for consumption and financial wealth in case the residence-based tax is introduced [i.e., expressions (28) and (34)] are found by solving (B.6) for $s = 0$. The adjustment speed h^* is the absolute value of the negative root of the first elasticity matrix at the right-hand side of (B.6).

The *time path for aggregate consumption* in case the source-based tax is introduced [expression (53)] is derived by substituting (B.8) into the first row of (B.6) to eliminate the initial change in financial wealth and using $\tilde{\omega}_I = \tilde{\omega}$, (47), (48), and the following steady-state relationship between consumption and after-tax labor earnings:

$$\frac{\omega}{C} = \frac{a_\omega}{a_c} = \frac{h^*(r^* + \theta)}{\Delta(n + \theta)} \ . \tag{B.9}$$

(B.9) is derived by substituting the steady-state values of financial and human wealth [from (8) and (A.6), respectively] into (7).

The initial relative change in consumption, $\tilde{C}(0)$, corresponds to the effect on the real wealth position of the currently alive. Expression (52) for this effect is found by using (B.8). If $\tilde{t}_r = 0$, the last term at the right-hand side of (B.8) is related to the effect on human wealth by

$$L_{\tilde{\omega}_I}(r + \theta) = \frac{\tilde{H}(0)}{(r + \theta)} \ . \tag{B.10}$$

Substituting (B.10), (49), and (51) into (B.8), one arrives at (52).

Appendix C: Welfare Analysis of the Residence-based Tax

Utility of a household born at time v is defined by expression (1) in Sect. 2. Assuming an iso-elastic utility function, one can write felicity $u(c)$ as:

$$u(c) = \frac{1}{1 - \sigma} c^{1-\sigma} \ . \tag{C.1}$$

The time path for consumption of a household born at time v is given by:

$$c(v, s) = c(v, t)\, e^{\left(\frac{r^* - \delta}{\sigma}\right)(s-t)}, \qquad s \geq t \geq v \ . \tag{C.2}$$

Substituting (C.1) and (C.2) into (1) and log-linearizing yields:

$$\tilde{W}^*(v,t) = \tilde{c}(v,t) - \frac{\tilde{\Delta}}{(1-\sigma)} \ . \tag{C.3}$$

Here, $\tilde{W}^*(v,t)$ is the relative change in real wealth that corresponds to the change in (ex-ante) utility enjoyed by a household born at v beyond time $t \geq v$. In other words, the welfare of the household would not be affected if one would reduce wealth by $\tilde{W}^*(v,t)$.

Linearizing (4) and (6), one finds:

$$\tilde{c}(v,t) = \tilde{\Delta} + \alpha_H \tilde{H}(t) \ , \tag{C.4}$$

$$\tilde{\Delta} = -\left(\frac{1-\sigma}{\sigma}\right)\frac{r\tilde{t}_r}{\Delta} \ , \tag{C.5}$$

where α_H is the wealth share of human wealth in the initial steady state. It is used that $r = r^*$ in the initial steady state and that $\bar{h}(t) = H(t)$. Furthermore, financial wealth A is not affected by the residence-based tax. The reason is that generations born at $t \geq 0$ start life without any financial wealth, while the financial wealth of those that are alive at $t = 0$ is fixed in the short run. The relative change in human wealth in (C.4) is found by using (A.7) and log-linearizing $\omega = w + t_k k f'(k) + t_r r A$. Substituting the resulting expression for $\tilde{H}(t)$ as well as (C.4) and (C.5) into (C.3), one arrives at the following expression for the welfare effect:

$$\tilde{W}^*(v,t) = -\alpha_H\left[\frac{A}{\omega}r\tilde{t}_r + \frac{1}{r+\theta}r\tilde{t}_r\right] + \frac{1}{\Delta}r\tilde{t}_r \ . \tag{C.6}$$

In order to find the welfare effect for current generations (24), one substitutes into (C.6) the initial steady-state values for α_H and (A/ω):

$$\alpha_H = \frac{h^*}{n+\theta} \ , \tag{C.7}$$

$$\frac{A}{\omega} = \frac{A}{(r^*+\theta)H} = \frac{(r^*-\delta)/\sigma}{h^*(r^*+\theta)} \ , \tag{C.8}$$

where (7), (A.6), and (B.9) are employed. The last term at the right-hand side of (24) is found by using $a_\omega = (1-\alpha_k)$, (22), and (B.9).

The welfare effect for generations born after the residence-based tax is introduced [expression (23)] is found by using (C.8) and setting the human wealth share, α_H, in (C.6) equal to 1, as these generations do not own any financial wealth at the beginning of their lives. The welfare effect for owners of financial wealth is used to find expression (36), which corresponds to the public debt that is needed to offset this welfare effect. This jump in public debt is found by setting the human wealth share in (C.6) equal to zero and using (37).

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